CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE Tosco-Federal 3 PAGE 1 OF

LOCATION Sec. ~~26~~ 23, T. 3 S., R. 96 W., Rio Blanco County, Colorado ELEVATION TOTAL DEPTH

DATE BEGUN 3/7 DATE COMPLETED DRILLER Longyear LOGGED BY G. N. Pipiringos

CASING REMARKS: HQ core 2-1/2" dia.

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	Sp. Gr. Est. GPI
1	0	20	20	No sample, no core	
2	20	22.2	2.2	Sandstone, light olive gray, v f grained, silty, calcareous, contains scattered biotite flakes and a few thin irr laminated zones of silty clay and a thin zone of dark mineral flakes near top	barren - lean
3	2.2	5.8	3.6	Siltstone, light olive gray, slightly calcareous, tuffaceous, contains flakes of dark mineral matter and thin zones of claystone and oil shale	barren - lean
	Heavy min.		22-23		
4	5.8	6.	0.2	Core loss	
5	6.	30.3	4.3	Siltstone, light olive gray, calcareous, sandy, obscurely bedded, contains dark mineral flakes	barren - lean
6	30.3	0.6	0.3	Sandstone, grayish orange v f grained siltstone, clayey, contains thin zones of dark mineral flaky aggregate	barren
7	0.6	2.4	1.8	Siltstone, like 5	barren - lean
8	2.4	3.2	0.8	Sandstone, like 6	barren - lean
9	3.2	9.6	6.4	Siltstone, like 5	barren - lean
10	39.6	40.1	0.5	Alternating beds of sandstone, siltstone, and ~~oil~~ shale	barren - lean

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CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE Tosco-Federal 3 PAGE 2 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
11	40.1	46.9	6.8	Sandstone, lt olive gray v f grained, calcareous tuffaceous, contains pink chalky grains, some biotite, zones of dk flaky minerals, and thin zones of olive gray siltstone and claystone in middle third	barren
12	6.9	7.1	0.2	Core loss	
13	7.1	53.7	6.6	Sandstone like 11, darker olive gray, clayey siltstone bands especially prominent at 49.2 - 52.3. Small cavities in leached zone at 49.5 - 49.6	barren
14	53.7	5.	1.3	Core loss	
15	5.5	7.5	2.5	Siltstone, light olive gray to pale brown, calcareous, darker bands are clayey, lighter bands are silty, V f grained sandstone, irregularly bedded, contains biotite and other dark mineral flakes	barren - lean
16	7.5	9.4	1.9	Sandstone, light olive gray, v f to fine grained, calcareous, tuffaceous, contains hexagonal biotite and other dark mineral flakes	barren
17	9.4	78.9	19.5	Siltstone, like 15; a 1/2" marcasite nodule occurs at 70.75 ft	barren - lean
18	78.9	85.	6.1	Sandstone, lt olive gray, v f grained, slightly calcareous, tuffaceous, contains pink chalky grains and dark mineral flakes and biotite, barren; with brownish gray, silty zones and inclusions of lean grade	barren - lean

Drill hole

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DRILL HOLE Tosco-Federal 3 PAGE 3 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
19	85	101.5	16.5	Siltstone, pale yellowish brown, wavy bedded, contains irregular thin zone of	barren - lean
				sandstone, pink grains, biotite, black organic flakes and white analcite?	
				aggregate; core loss at 85.45- 85.6, 85.7-86.1 and 100.9 - 101.5; leached zones	
				at 86.1, 87.4 and 88.5; fragment of small leaf and peticle at 85.65	
20	101.5	15.	13.5	Same as 19, but sandstone slightly more abundant than siltstone; coalified plant	
	Hole mis	112-113		fragment at 103; marcasite nodule at 111.15-111.2; core loss 105-110, rock bit,	
				no sample	
21	15.	17.9	2.9	Siltstone, light olive gray v f grained, calcareous, contains biotite and dark	barren - lean
				organic flakes, contains a few thin tuffaceous sandstone beds, and a porous	
				micro-vuggy zone in basal 0.5 ft	
22	17.9	25.3	7.4	Sandstone and clayey siltstone in about equal parts; like beds 19 and 20;	barren - lean
				contains 1/2" zones of marcasite at 118.6 and 121.8, thin porous micro-vuggy	
				zones at 118.85 and 119.4	
23	25.3	34.	8.7	Siltstone, olive gray with lesser amounts of light olive gray sandstone, like bed 19,	lean
				thin marcasite nodule at 129.35	
24	134	135		Sandstone, light olive gray v f grained, calcareous, contains biotite flakes,	barren - lean
				small thin stringers of organic matter, disseminated small marcasite aggregates,	
				micro vugs, some of which contain minute calcite crystals and white chalky	
				grains of analcite; unit probably tuffaceous	

Drill hole

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U. S. GEOLOGICAL SURVEY

DRILL HOLE Tosco-Federal 3 PAGE 4 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
25	135	153	8	Siltstone with lesser thin zones of sandstone; like 23 thin marcasite nodules	lean
	Hang Min 142-143			at 149.8	
26	53	53.6	0.6	Sandstone like 24, contains marcasite nodule at top; minor thin zones of siltstone	barren - lean
27	53.6	59.3	5.7	Siltstone with sandstone bands, like 25	lean
28	59?3	82.2	22.9	Siltstone, light olive to olive gray, calcareous, irregularly banded, two zones	lean
	Hang Min 172-173			more evenly banded in top 2.5 ft, irregular stringers of black organic matter	
				common throughout vuggy zone at 167.2, marcasite nodules at 163.7, 175.4,	
				176.8, 177.5 and 178.9	
29	82.2	87.5	5.3	Sandstone, light olive gray, v f to f grained, calcareous, micro-vuggy, biotitic,	barren - lean
				with zone of organic-bearing siltstone, dark flakes of organic matter throughout	
				marcasite nodule at 183.9 and 185.3, disseminated marcasite common 185-187.5	
30	87.5	207.5	20.0	Oil shale and siltstone, interdominated, olive gray, calcareous stringers of	± 15-20 glt
				marcasite and coaly matter common	
31	207.5	209.4		Siltstone as in 30	lean
	Hang Min 208-209				

Drill hole

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DRILL HOLE Tosco-Federal 3 PAGE 5 OF _____

LOCATION _____ ELEVATION _____ TOTAL DEPTH _____

DATE BEGUN _____ DATE COMPLETED _____ DRILLER _____ LOGGED BY _____

CASING _____ REMARKS: _____

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
32	209.4	210.2	0.8	Oil shale, grayish brown, slightly calcareous, silty, massive, contains nodules and lenses of marcasite	fair
33	210.2	23.1		Oil shale and siltstone, as in 30; thickest band of oil shale is at 218.9-219	fair
34	23.1	31.5	8.4	Siltstone, brownish gray, slightly calcareous, massive, contains flakes of organic matter	lean
35	31.5	32.3	0.8	Siltstone, brownish gray and sandy siltstone, yellowish gray w/dark flakes of organic matter	lean
36	32.3	36	3.7	Zebra striped silty oil shale and sandy siltstone, marcasite at 234.4-234.5 and 236	lean
37	36	38.2	2.2	Oil shale, olive gray w/minor thin bands of siltstone	lean
38	38.2	40.8	2.6	Siltstone, brownish gray and oil shale dark yellowish brown in beds 0.1-0.8 ft thick zone of disturbed bedding in oil shale at 239.7 - 240.5	lean
39	240.8	242.5	1.8	Siltstone, brownish gray with minor darker laminae and bands	lean
	Fossils ~ 241-242				
				Possible contact of Evacuation Creek with Parachute Creek Member	

Drill hole

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DRILL HOLE Tosco-Federal 3 PAGE 6 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
40	242.5	261.8		Oil shale, brownish gray to pale brown, thinly varved, calcite	± 18-12-9 GT
41	61.8	63.5	1.7	Siltstone, yellowish gray thin bands and laminae of darker siltstone, coalified	lean - barren
				strap-like leaf fragments common	
	63.5	64.	0.5	Core loss	lean - barren
42	64.	72.7	8.7	Siltstone, like 41	
	72.7	73.	0.3	Core loss	
43	73.	87.3	14	Siltstone, like 41; fracture surface at 279-279.1, dips about 65°, coated with	barren - lean
				marcasite aggregates, and clear tabular gypsum crystals, some sandy layers less	
				than 1 inch thick; vuggy thin layers, spheroidal grains of marcasite on fracture	
				surfaces at 275, 277.7, 278.1, 281.8	
44	87.3	92.9	5.6	Siltstone and tuffaceous sandstone in beds 1/4 inch to 0.6 ft thick, vuggy zones	barren
				at 289.8 - 290 and 292.3-292.5. The siltstone is banded as in 41; the sandstone	
				is fine grained, analcitic, tuffaceous and contains interstitial dark grain	
				aggregates. Cavities in the vuggy zones are filled with clear xtals of gypsum(?)	
				and dark blackish-brown tarry substance similar to the interstitial material	
45	292.9	293.5	0.6	Siltstone, light olive gray with medium gray fine grained bands, slightly	barren - lean
				calcareous, some fine grained aggregates of marcasite	

Drill hole

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DRILL HOLE Tosco-Federal 3 PAGE 7 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
46	293.5	295.3	1.8	Mostly siltstone with thin bands of tuffaceous sandstone; marcasite nodules at 294-294.2, blackish brown substance as in 44; coating fracture surface at 295; same substance probably scattered as flakes throughout interval	barren - lean
47	95.3	305.	9.7	Siltstone, pale brown with 1/4" thick oil shale beds at 295.4 and 296.25; tuffaceous sandstone zones at 297.4 - 297.65, 298.5-298.7, 299.75- 299.85, and 303.7- 304.3; marcasite nodules at 297.6 and 302.9- 303; bedding plane at 303.2 studded with clear and chalky gypsum(?) xtals, flakes, blackish brown matter throughout	lean
48	305.	09.	4	Siltstone, pale brown, like 47 but generally finer grained, contains fewer zones of tuffaceous sandstone; chalky white analcite(?) grains more conspicuous in the siltstone	barren - lean
49	09.	11.75	2.75	Siltstone, pale brown to brownish gray, slightly calcareous; contains zones of lean oil shale in zone 310.2- 310.6, a nodule of tuffaceous siltstone at 310; minute aggregate of marcasite in zone 309.3- 310.7	barren - lean
50	311.8	312.6	0.8	Siltstone, pale yellowish brown, calcite, massive with yellow gray nodules and lenticles scattered throughout	barren - lean

Drill hole

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DRILL HOLE Tosco-Federal 3 PAGE 8 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
51	312.6	320.3	7.7	Siltstone and oil shale like 49. Oil shale zones at 313.4- 313.5, 314.25 - 314.7, 315.5- 315.6, 316.05 - 316.45, 317 - 317.1	barren - lean
52	20.3	22.75	2.45	Oil shale, pale yellowish brown, varved, slightly calcitic, contains thin marcasite nodules at 321.35 and 322.46; tuffaceous siltstone at 320.31-320.36, 320.45- 320.48 and 322.57- 322.62	fair (15-18GT)
53	22.75	23.25	0.5	Siltstone, pale brown, like 47; contains oil shale zone 322.96- 323.02	lean
54	23.25	23.6	0.35	Oil shale like 52	fair
55	23.6	25.35	1.75	Siltstone and oil shale as in 53 and 54. Oil shale zone at 324.18-324.21, 324.33 - 324.4 and 324.65 - 324.87	lean
56	25.35	26.65	1.3	Oil shale as in 52; siltstone zones at 326.35 - 326.38 and 326.53 - 326.6, Marcasite nodule at 326.2, minute flattened spheroidal aggregates of marcasite on fracture surfaces extending from 325.6-325.8 and from 326.2-326.35	lean - fair
57	26.65	27.35	0.7	Siltstone, like 47	barren - lean
58	327.35	333.65	6.3	Oil shale like 52; contains thin calcite and analcite zones at 329.1 and 330.02; siltstone with dark organic mineral flakes at 331.7- 331.85	± 24 g/t

Drill hole

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DRILL HOLE Tosco- Federal 3 PAGE 9 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
59	333.65	341.65	8	Siltstone, like 47; contains thin zones of oil shale 334.5- 334.7, 338.2-338.4	barren - lean
				and 338.65-338.75; marcasite nodules at 338.35; and marcasite xtals on fracture	
				surfaces at 339.5- 340.1 and at 340.3-340.4	
60	41.65	48.	6.35	Siltstone and oil shale in beds 1/4" to 1 ft thick, marcasite nodules at	barren - lean
				344.15-344.3; thin irregularly bedded analcitic sandstone stringers	
				344.5-345; thickest beds of oil shale occur at 341.6- 342.2, 343.25-343.65,	
				345.6-345.9 and 347.3 - 348; many fracture surfaces studded with flattened	
				spheroidal aggregates of marcasite	
61	48.	55.	7	Siltstone like 47; contains one thin oil shale zone at 350 and one at 351.8;	lean - barren
				marcasite aggregates occur on most fracture surfaces	
62	55.	55.6	0.6	Oil shale, dark yellowish brown, varved, fracture surface at 355-355.2 lined w/	9 g/t
				marcasite aggregates and clear tabular gypsum xtals	
63	355.6	361.05	5.45	Siltstone, pale brown, slightly calcitic, contains abundant dark organic mineral	barren - lean
				flakes, and chalky gypsum or analcite grains, all fracture surfaces studded by	
				marcosite aggregate and clear gypsum xtals; surface from 359.4 - 360.4 are	
				studded with perfect octagons and a few perfectly spheroidal marcosite xtals	
				and aggregates	

Drill hole

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U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3 PAGE 10 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
64	361:05	362.46	1.41	Oil shale, like 62) fractures lined with marcasite xtals as in 63	lean (12GT)
					6.8 av.
65	62.46	63.	0.54	Siltstone, like 61)	barren
					fair
66	63.	64.7	1.7	Oil shale, like 62) contains analcitic, marcasite lined nodules at 363.4, 363.6 and 364.5	lean (18GT)
67	64.7	80.8	16.1	Siltstone, like 61) contains thin oil shale zones at 370.5, 370.7, 373.8, 374.5, 375.1, 377.5-378.3, and at 379.15-379.4; and a thin chalky white tuffaceous layer at 379.35	11.3 av.
68	80.8	89.2	8.4	Siltstone, like 61) no oil shale layers; only 1 fracture surface coated with marcasite xtals at 387.7-387.9	6.2 av.
69	89.2	92.57	3.37	Oil shale like 62) contains zones of siltstone at 389.75-389.9, 391.95-392.2 and 392.25-392.35	mod (20GT) 1.5
70	92.57	401.02	8.45	Siltstone like 61) contains a layer of oil shale at 393.03-393.4 and a thin band at 396.4 and one at 398.6; in 399-400.4 oil shale beds are minor and too thin to describe separately	barren - lean 1.8 INCL. CORE LOSS 397-399
71	401.02	401.57	0.55	Analcite and some calcite, silty, with very thin oil shale laminae	barren

Drill hole

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U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3 PAGE 11 OF _____

LOCATION _____ ELEVATION _____ TOTAL DEPTH _____

DATE BEGUN _____ DATE COMPLETED _____ DRILLER _____ LOGGED BY _____

CASING _____ REMARKS: _____

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
72	401.57	403.47	1.9	Siltstone like 61) contains thin layer of oil shale just below a thin layer of analcite	Barren-lean 1.5
				and marcasite at top	
73	403.47	433.7	30.23	Oil shale dk to dusky yellowish brown, contains tuffaceous sandstone and ~~siltstone~~	15-27 av: 20GT
				siltstone at 411.9-412.2, 411.3-411.9, 419.87-419.96, 420.4-420.9, analcite and	(420.9 (R) -421.9= 30 ~~35~~GT)
				gypsum? layers and nodules at 419.2-419.3, 423.3 and at 424.9-425. Fractured	(421.9 (F) -425.6= 15GT)
				surfaces lined with marcasite octagons	(425.6 (F) - 428= 18GT
				(R)	428-429 = 46 GT
					429-(F)-433.7 = 18 GT
74	33.7	41.7	8	Siltstone, pale brown, sandy, slightly calcareous, contains chalky analcite,	barren
	Hem Min 440-441			biotite? and dark organic flakes; fracture surface at 434-435 coated with brown	
				resinous substance; entire interval is micro-vuggy	
75	41.7	43	1.3	Oil shale, dusky yellowish brown, varved, ✓ fine grain marcasite common	Rich 40GT
76	43	70.5	27.5	Siltstone as in 74) fracture surface at 458-459 coated with marcasite aggregates,	barren
				several other fracture surfaces also coated with marcasite aggregates	
77	470.5	473.5	3	Oil shale, top 1-ft contains several thin siltstone layers; layer of analcite	mod
				xtals 470.5-470.55	

Drill hole

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U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3 PAGE 12 OF _____

LOCATION _____ ELEVATION _____ TOTAL DEPTH _____

DATE BEGUN _____ DATE COMPLETED _____ DRILLER _____ LOGGED BY _____

CASING _____ REMARKS: _____

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
78	473.5	476.9	3.4	Siltstone, like 74)	barren - lean
	Hermosa 474-475				
79	76.9	78.6	1.7	Oil shale, like 75)	15-20 GT
80	78.6	93	14.4	Siltstone, like 74) contains a few thin layers lean-grade oil shale and a few thicker layers of fair-grade oil shale in 484-486 and 488-489 intervals	barren - lean
81	93	99.6	6.6	Oil shale and siltstone about half and half like ~~both~~ eds 74) and 75) neither lithology exceeding 1/2 ft layers	barren - lean
82	99.6	502.6	3	Siltstone like 74)	barren - lean
83	502.6	07	4.4	Oil shale like 75)	25 GT mod
84	07	14.4	7.4	Siltstone, light olive gray, contains very thin zones of oil shale and very fine grained marcasite	barren - lean
	Hermosa 504-507				
85	14.4	19.8	5.4	Oil shale, dusky brown, varved, like 75)	25 GT - mod
86	519.8	520.4	0.6	Siltstone, like 84) probably tuffaceous, contains 1/2 in. oil shale parting near middle	barren - lean

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U. S. GEOLOGICAL SURVEY

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DRILL HOLE TG2-3 ELEVATION _____ TOTAL DEPTH _____

LOCATION _____

DATE BEGUN _____ DATE COMPLETED _____ DRILLER _____ LOGGED BY _____

CASING _____ REMARKS: _____

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
87	520.4	546.1	25.7	Oil shale, dark to dusky yellowish brown, contains very thin analcitic siltstone	fair - mod
				layers at 521.35, 521.5, 522.05, 523.3, 523.83, 530.32, 531.13, 531.22, 533.91.	
				Interval contains ~~limestone~~ est. 15-25 GT except 530.7- 532.25 which appears to be	
				of 40 GT grade	
					barren
88	46.1	46.25	.15	Tuffaceous siltstone	
					fair - mod
89	46.25	49.48	3.23	Oil shale, dark yellowish brown, like 87); analcitic partings at 538.2, 539.1	(13-21GT)
				540.47, 541.43, 541.85, 542.7, 542.87, 543.3, 544.15, 545, 545.23, and 545.35;	
				contains siltstone layer at 546.1- 546.25 and another analcitic parting at	
				549.05	
					rich (40 GT)
90	49.48	52.27	2.79	Oil shale, dusky brown, varved, contains analcitic partings at 552 and 552.15	
					fair - mod
91	52.27	60.7	8.13	Oil shale, like 87) contains zone of thin layers and nodules of analcite	(12-25 GT)
				and marcasite intergrowths at 558.75 - 558.85	
					rich (39-41 GT)
92	60.7	65.2	4.5	Oil shale, dusky brown, like 90) bedding distorted at 561.3-562; fracture surface	
				565-565.2 coated with blue-white analcite	
					barren
93	565.2	565.5	0.3	Analcite and gypsum intergrowths in what appears to have been a leached zone	

Drill hole

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CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3 PAGE 14 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
94	565.5	577	11.5	Oil shale, dark yellowish brown to dusky brown, very thin analcitic zones at	AV.(EST.)
				568.16, 568.33, 568.6, 568.82, 569.3, 569.65, vuggy analcite nodule at 574.9;	25 GT
				565.5-566.8: 18 GT; 566.8-567.65: 24 GT; 567.65- 569.4: 17 GT; 569.4-571.2: 12 GT;	
				571.2-573.95: 40 (TG); 573.95-577: 28 GT	
95	77	83	6	Oil shale, dark yellowish brown, analcite layer at 577.15, 577.45, and 582.95;	Fair (18 GT)
				very thin layers of, and disseminated, pyrite throughout	
96	83	84.5	1.5	Oil shale, like 92)	Rich (45 GT)
97	84.5	86.1	1.5	Oil shale, like 95)	Fair (19 GT)
98	86.1	86.3	0.2	Analcite, vuggy	barren
99	86.3	87.1	0.7	Oil shale, like 95)	fair
100	87.1	87.2	0.1	Analcite, like 98)	barren
101	87.2	91.6	4.4	Oil shale, like 97)	fair (19 GT)
102	591.6	593.6	2.0	Oil shale, like 97)	fair (15 GT)

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CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3 PAGE 15 OF _____

LOCATION _____ ELEVATION _____ TOTAL DEPTH _____

DATE BEGUN _____ DATE COMPLETED _____ DRILLER _____ LOGGED BY _____

CASING _____ REMARKS: _____

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
103	593.6	595	1.4	Oil shale, like 97)	mod (22 GT)
104	95	97.42	2.42	Oil shale, like 97)	mod (26 GT)
105	97.42	97.54	0.12	Tuffaceous siltstone, analcitic	barren
106	97.54	98.36	1.82	Oil shale, yellowish brown, thin tuffaceous siltstone layer at 598.22	fair (20 GT)
107	98.36	98.7	0.34	Tuffaceous, analcitic siltstone, like 105	barren
108	98.7	604.25	5.55	Oil shale, pale yellowish brown, tuffaceous analcitic siltstone layers at 599.95, 600.42-600.7, 602.2, 602.75 - 602.9, and 603.5- 603.55	fair (16 GT)
109	04.25	05	0.75	Oil shale, dusky brown	rich (43 GT)
110	05	06	1	Oil shale, dusky yellowish brown	mod. (23GT)
111	06	10	4	Oil shale, dusky brown; thin tuff. layers at 607.85, 607.92, 608.06, 608.25	rich (37GT)
112	10	12	2	Oil shale, dark yellowish brown, layers at 611.2, 611.3, 611.4	fair
113	612	613	1	Oil shale, pale yellowish brown, very silty, almost a siltstone, calcareous	lean

thin tuff

Drill hole

GPO 846-153

CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3

LOCATION

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ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
114	613	613.4	0.4	Tuffaceous siltstone, bentonitic?	barren
115	13.4	617	3.6	Oil shale, dusky yellowish brown, analcitic siltstone partings at 615.15, 615.2-	rich (43 GT)
				615.3, 615.4 and 616.35	
116	17	18.86	1.86	Oil shale	mod (22 GT)
117	18.86	21	2.14	Oil shale, analcite parting at 620.14	fair (19 GT)
118	21	21.05	0.05	Analcite parting	barren
119	21.05	21.8	0.75	Oil shale, analcite at 621.65	lean (8 GT)
120	21.8	23.6	1.8	Oil shale, analcite at 623.45	mod (25 GT)
121	23.6	24.5	0.9	About equal parts analcitic partings and oil shale in beds up to 0.2 ft thick	barren - lean
122	24.5	26.35	1.85	Oil shale, like 120) analcite parting at 624.65	mod (23 GT)
123	26.35	31.92	5.57	Oil shale, like 117) analcite partings at 627, 627.6, 628.3, 629.08, 630, 630.22	fair (14 GT)
				and 631.7; nearly all joint surfaces lined with analcite	
124	631.92	633.75	1.83	Oil shale, like 120), analcite parting at 632.83	mod (20 GT)

Drill hole

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CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3A

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LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
	633.75	636	2.25	Core loss	
	36	40	4	Not cored. TG2-3A core begins at 640	
125	40	46.5	6.5	Oil shale, dusky brown to grayish brown, obscurely finely laminated, calcareous,	
				contains lenses of darker material, bedding planes show black organic films;	
				contains nodular analcite at 642.1, 643.6 and in vuggy zone 645.65 - 645.8;	
				latter also lined with marcasite and some calcite; joint and bedding plane	
				fractures at 643.5 - 643.9 lined with finely xtln calcite; thin calcite layer	
				at 645.3	
126	46.5	50.7	4.2	Oil shale, dark yellowish to grayish brown, conspicuously varved, contains dark	
				analcite bands that seem leached and very thin black organic layers; 1/2 inch	
				thick analcite layer at base	
127	50.7	52.4	1.7	Oil shale, dusky yellowish brown, varved; vuggy at 651.6 - 651.8	
128	52.4	64.8	12.5	Oil shale, grayish brown to dusky brown, vuggy leached zone at 653 - 653.5;	
				stellate clusters of blade-like aggregate partly leached, partly filled with	
				marcasite, analcite and calcite at 654-656; irregular analcite blebs at 657.6 and	
				659-663.8; occasional fractures at 60° to the bedding lined with calcite and	
				analcite(?).	
129	64.8	69	4.2	Oil shale, grayish brown to dusky brown same as 128); contains vuggy zone at	
				667-668 whose sides are coated with marcasite, calcite and analcite	
130	69	70.2	1.2	Core loss as marked on core. Assay sheets give loss at 667.3 - 668.5	
131	670.2	684.2	14	Oil shale, grayish brown, obscurely banded, contains stellate blade-like cavities	
				in vuggy zones 674-674.2, 677.7-678.9, 680-682, joints and irregular fractures	
				are calcite filled	

Drill hole

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CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3A

PAGE 18 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
132	684.2	691.9	7.7	Oil shale like 131) but banding more distinct; contains very thin darker blebs of analcite, calcite and marcasite	
133	91.9	97.8	5.9	Oil shale, mod to grayish brown, banding indistinct, micro-lenticles of coaly matter at 692.2-692.3; vuggy zone 695.1-695.2	
134	97.8	703.6	5.8	Oil shale, distinctly banded gray and grayish brown, bedding disturbed at 697.8-700, contains analcite blebs at 703.2-703.3	
135	703.6	29	25.4	Oil shale, dark yellowish to dusky yellowish brown; irregularly shaped lens of marcasite, calcite and analcite intergrowths at 715.9-716.1; disturbed bedding at 723.6-724.2 and 725.5-726; analcite nodules at 726 and 726.5	
136	29	32.8	3.8	Oil shale, banded mod yellowish brown (light) and dusky brown (dark); stellate vuggy zone lined with marcasite, analcite and calcite at 729-729.2; at 730.5-732 banding is conspicuous; contains two layers of marcasite 1/4-1/2 in. thick at 731-731.3 and two layers of tuff 1/8-1/2 in. thick at 731.05 and 731.2	
137	32.8	39	6.2	Oil shale, grayish brown core broken because of leached vuggy zones to 735; rest of interval pale to mod yellowish brown, bedding very thin but indistinct for lack of contrasting more organic rich layers; broken into plates 1 in. thick av	
	39	47.7	8.7	Core lost	
138	47.7	51.2	3.5	Oil shale, grayish brown to dusky brown, bedding indistinct except in top 1 ft where light and dark banding is conspicuous	
139	751.2	754	2.8	Sandstone, pale yellowish brown, tuffaceous, analcitic (~~MAHOGANY MARKER~~?)	
	Zircon	Sample	?		
	Sample #13				

Drill hole

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CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3A PAGE 19 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
140	754	768.4	14.4	Oil shale distinctly banded although locally irregularly bedded, contains analcite nodules scattered throughout, thin tuff beds at 757, 757.7, 758, 763.85, 764.05, 765.75 and many thin ones in a zone: 767.8-768.4; marcasite nodules at 764 and at top of interval; (darkest brown zone from 763-764.5 may be ~~MAHOGANY BED~~?)	
141	68.4	82.1	13.7	Oil shale, dark yellowish to grayish brown, bedding somewhat indistinct; tuffaceous nodules at 769.75, tuffaceous sandstone at 778-778.7, and 780.4 and 780.7 1/4-1/2" thick; marcasite nodule at 779.2; all slightly calcareous except near tuff beds	
142	82.1	87	4.9	Oil shale, (more distinctly banded than 141) - darkest and most conspicuously banded at 782.7-783.8; tuff beds 1/4-1/2 in. thick at 782.4	
143	87	92.7	5.7	Oil shale, like 141)	
144	92.7	99	6.3	Oil shale, like 142), especially conspicuously banded at 794.3 - 797	
145	99	841	42	Oil shale, dusky brown, bedding indistinct, leached zones at 832.5 and 838.5, darkest and most disturbed part interval is at 832.6 - 835.5; fractures are lined with bluish white analcite-calcite	
146	841	44.5	13	Oil shale, dusky yellowish brown, bedding indistinct, irregular aggregate and marcasite, analcite, calcite at 843.2	
	44.5	46.1	1.6	Core loss	
147	46.1	54	7.9	Same as 146, tuffaceous analcitic rounded blebs 1/4" thick or less are common in lower 3 ft	
148	854	855	1	Oil shale, pale yellowish brown, brecciated, apparently due to leaching, then recemented with analcite and calcite	

Drill hole

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CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3A PAGE 20 OF

LOCATION ELEVATION TOTAL DEPTH

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CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
	855	856	1	Core loss	
149	56	57.3	1.3	like 148) brecciated oil shale	
	57.3	58.3	1	Core loss (not recorded in TOSCO assay report)	
150	58.3	65.8	7.5	Oil shale, mod to grayish to dusky yellowish brown, brecciated zones at 860-860.5	
				and 862.2-862.7; fractures filled with calcite-analcite	
151	65.8	66.5	0.7	Core loss (not recorded in TOSCO assay report)	
152	66.5	70	3.5	Oil shale as in 150) brecciated zone 869.1 - 870	
	70	70.6	0.6	Core loss (not recorded, TOSCO)	
153	70.6	74	3.4	Oil shale as in 150) fractures lined and partly filled with analcite and calcite	
				xtals; analcite layers at 873.4-873.6	
154	74	86.4	12.4	Oil shale, like 150) vuggy zones at 876.2-876.3, 880.6-881, 885-885.1, 885.7-886,	
				dark and conspicuously banded at 882.7-883.7; a 1/4" thick tuff at 882.75	
155	86.4	91.5	5.1	Oil shale, yellowish brown, mostly brecciated	
	91.5	91.7	0.2	Core loss	
156	91.7	95.7	4	Mostly tuff interbedded with yellowish brown oil shale	
157	95.7	908.7	13	Oil shale, grayish brown bedding inconspicuous, fracture filled with white	
				calcite; core broken, probably because of leaching at 899.5-900.3, 902.-903.5,	
				905-906, 907-907.8, 908.3-908.7; tuff beds at 906.4-907 and 907.8-908.3	
	908.7	10.2	1.5	Core loss	
158	910.2	913.6	3.4	Oil shale, same as 157, core broken at 910.2-910.6, 912.1-912.8, 913.1-913.6;	
				porous tuffaceous layer at 912-912.1	

Drill hole

CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3A PAGE 21 OF

LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
159	913.6	916.2	2.6	Oil shale, dark yellowish brown, mod well banded, vugs are small and lenticular	
	16.2	37	20.8	Core loss	
160	37	40.1	3.1	Oil shale, dark yellowish brown, vuggy zones at 937-937.3 and 939.9-940, bedding	
				lenticular and indistinct	
161	40.1	44.5	4.4	Oil shale, mod brown, core broken into irr chunks at top and bottom, middle is	
				V thin bedded, flat bedded and broken into plates 1/8-1" thick	
162	44.5	45.9	1.5	Oil shale, dark yellowish brown, banded dusky brown, distinct but wavy bedded;	
				white tuff at 945-945.1	
163	45.9	47	1.1	Oil shale, broken core as in /158	
164	47.	51.3	4.3	Oil shale, dark yellowish brown, thin and flat bedded, vuggy at 947.8-947.9.	
				Core irregularly broken at 948.5 - 950.5	
	51.3	53.7	2.4	Core loss	
164A	53.7	58.6	4.9	Oil shale, like 164) broken into thin flat bedded plates at 954.6-954.8;	
				irregularly lenticular nodules of marcasite and analcite at 954.8-955; a lens	
				of gilsonite, black with concoidal fracture, vitreous luster at 958	
165	58 6	60.1	1.5	Tuffaceous oil shale breccia with zone of grayish white tuff at 959.2-959.3	
166	60.1	67	6.9	Oil shale, dark yellowish brown, core vuggy and broken at 960.1-962, core	
				obscurely bedded 962-965, bedding is irregular but moderately distinct at 965-967;	
				white and brown nodule and layer of analcite-calcite at 955.6 and 965.9 respectively	
167	967	972	5	Oil shale, dusky yellowish brown; bedding obscure and irregular; vuggy broken	
				zone at 968.5-970; bedding disturbed at 970.8-971.2	

Drill hole

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CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3A PAGE 22 OF

LOCATION ELEVATION TOTAL DEPTH

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CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
168	972	981	9	Oil shale, pale to dk yellowish brown, bedding mod distinct as at 965-967;	
				vuggy broken core zones at 975.2-975.7 and 978-979.3; small marcasite-filled	
				vugs at 975.7-976, near 978, and at 980.6-980.8	
169	81	91.7	10.7	Oil shale, dusky yellowish brown, obscurely bedded, lighter parts of shale make	
				abundant short thin blebs; aggregates of blade-like cavities 1" to 0.3 ft are	
				common; a 1/8" layer of analcite at 984.25; "X" shaped marcasite fills at	
				984.8-985.1	
	91.7	94	2.3	Core loss	
170	94	1002.7	8.7	Oil shale, like 169) but with mod distinct bedding except in bottom 1 ft;	
				contains a 1" thick tuff at 995.6; contains a vug in basal 0.5 ft	
171	1002.7	07.1	4.4	Oil shale, dark yellowish brown, mod distinctly bedded, broken into irr chunks	
				from 1003.8-1007.1	
	07.1	10.6	3.5	Core loss	
172	10.6	14.4	3.8	Oil shale like above, with alternating zones of obscure and distinct bedding;	
				vugs at 1011.9-1012.1 and at 1013.4-1013.6	
173	14.4	17.2	2.8	Oil shale, dusky yellowish brown, mod to obscurely bedded, pale grayish brown	
				blebs at 1015.7-1016.1	
	17.2	17.6	0.4	Core loss	
174	1017.6	1018.2	0.6	Oil shale, like blebby part of 173)	

Drill hole

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U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3A PAGE 23 OF _____

LOCATION _____ ELEVATION _____ TOTAL DEPTH _____

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CASING _____ REMARKS: _____

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
175	1018.2	1021	2.8	Oil shale, dusky yellowish brown, mod distinctly bedded	
176	21	23.6	2.6	Tuff bed with vuggy zones at 1021.5-1021.7 and 1022.6-1023.2; and pale grayish brown oil shale at 1021.5-1022.4	
177	23.6	27.6	4	Oil shale, dark grayish brown obscurely bedded, except in basal 0.6 ft; vuggy zones and broken core at 1025.2-1025.4 and basal 0.2 ft	
	27.6	28.6	1	Core loss	
178	28.6	30	1.8	Oil shale, pale yellowish brown, mostly broken core	
179	30	30.9	0.5	Oil shale with 3 tuffaceous beds 0.2 ft, 1/4", one 1/2" at top, middle and bottom	
180	30.9	33.2	2.3	Oil shale, dark yellowish brown, wavy bedded with microvuggy small analcite aggregate	
181	33.2	34.5	2.3	Oil shale, dark yellowish brown, mod well bedded	
	34.5	35.5	1	Core loss	
182	35.5	46.5	11	Oil shale, dark yellowish brown except 1036.65-1037.75 which is dusky brown, distinctly banded, thin marcasite layers and blebs common; tuffaceous layers in zone 104.25-1040.6 - 1042.3-1042.4, and at 1045.9 fractures coated with bluish white chalky analcite	
183	46.5	49	2.5	Oil shale, dark to dusky yellowish brown, blebby as in 173)	
184	49	1053.5	4.5	Oil shale, like 182; contains tuffaceous layers at 1049.35, and 1052.1-1052.4, core broken at 1051-1052 and at 1053-1053.5	
	1053.5	1055	1.5	Core loss	

Drill hole

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CORE LOG

U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3A

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LOCATION ELEVATION TOTAL DEPTH

DATE BEGUN DATE COMPLETED DRILLER LOGGED BY

CASING REMARKS:

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
185	1055	1059.5	4.5	Oil shale, mod well banded, like 182; contains zone saturated with dried hydrocarbon at 1055.1-1055.4	
	59.5	64	4.5	Core loss	
186	64	66	2	Oil shale, dark yellowish brown, indistinct bedding, small pale grayish brown blebs common	
187	66	75	9	Oil shale, mod distinctly banded, thin layers and zones of marcasite, analcite and tuff are scattered throughout; core vuggy and broken at 1066-1067, 1069.6-1070, 1070.8-1072, and 1073.9-1075	
	75	78.1	3.1	Core loss	
188	78.1	83.5	5.4	Oil shale like 187) but lacks analcite and tuff layers	
	83.5	88	2.5	Core loss	
189	88	89.2	1.2	Oil shale like 187) mostly broken, lacks marcasite, analcite and tuff	
190	89.2	92.2	3	Oil shale, irr bedded, blebby, like 186	
191	92.2	99.1	6.9	Oil shale, like 187) core vuggy and broken at 1098-1099.1	
192	99.1	1100	0.9	Core loss (not reported in Tosco Assay report)	
193	1100	11	11	Oil shale, like 187) core vuggy and broken at 1100-1101 and 1103.5-1104.9; thin analcite layers at 1104 and 1106.1	
194	1111	1114	3	Oil shale, pale yellowish brown to mod brown, bedding mod obscure to obscure, grayish orange tuffaceous blebs and layers at 1111-1112.1, 1112.8-1113.5, 1113.5-1114	

Drill hole

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U. S. GEOLOGICAL SURVEY

DRILL HOLE TG2-3A

LOCATION _____ ELEVATION _____ TOTAL DEPTH _____

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CASING _____ REMARKS: _____

	FROM	TO	THICK-NESS	LITHOLOGIC DESCRIPTION	
195	1114	1120.5	6.5	Oil shale, dark yellowish brown and grayish brown, distinctly banded, marcasite in thin layers, irr aggregates, and minutely disseminated throughout; contains a brecciated tuff bed with intersticed analcite and pyrite at 1119.6-1119.8, an analcite layer at 1118.9 and an irr vug at 1120.1	
196	20.5	22.3	1.8	Oil shale, like 195) but brecciated and microfaulted	
197	22.3	23.5	1.2	Oil shale, banded like 195) but contains zones of finely disseminated chalky analcite at top and bottom	
198	23.5	29.8	6.3	Oil shale, tuffaceous and analcitic throughout, analcite occurs in chalky layers, nodules and finely disseminated; core broken at 1124.1-1126.5; marcasite occurs throughout as minute lath-like aggregates	
	1129.8	1130.7	0.9	Oil shale, like 195, core broken into plate 1/2 - 2" thick; contains minute lenticular analcite-marcasite aggregate	
				BOTTOM OF HOLE	

drill hole

GPO 846-183